SCIENCE.

FRIDAY, MAY 17, 1895.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison on Hudson, N. Y.
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THE BALLISTIC GALVANOMETER AND ITS USE IN MAGNETIC MEASUREMENTS.

THE ballistic galvanometer gives one of the most convenient and reliable means of measuring the total quantity of electricity conveyed through a circuit by a transient current when the conditions are such as to admit of its legitimate application. It is well known, however, to experienced observers that in a large number of the common applications of the instrument the results are doubtful because the fundamental principle on which the calculations are based is not sufficiently attended to. The object of the present note is to direct more particular attention to the conditions under which accurate results may be obtained.

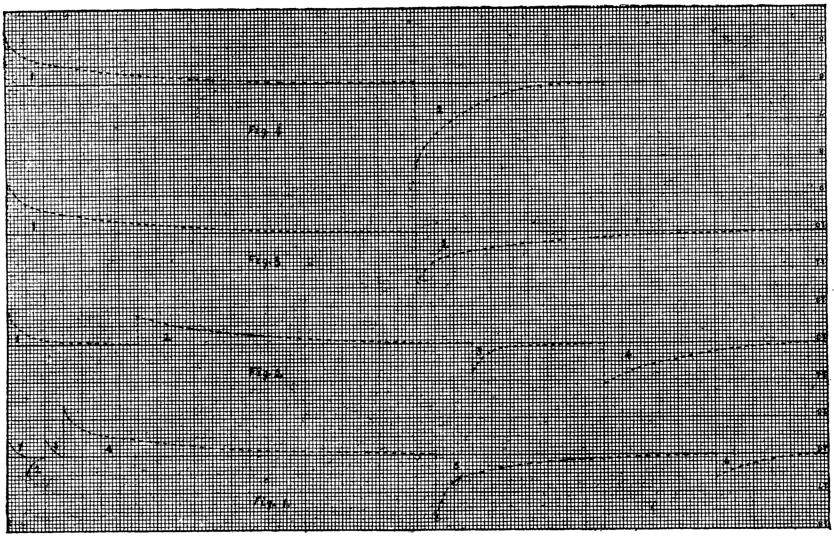
Most text-books on electrical measurements give formulæ for the calculation of the quantity of electricity required to produce a given deflection, or throw, of the galvanometer needle, and also indicate how the constant of the instrument may be determined, and how the damping effect of the air and of induced currents may be allowed for. The formulæ assume as fundamental that the duration of the flow is negligibly small in comparison with the time which the needle takes to reach its greatest deflection. This fundamental condition is of course implied in the name ballistic, but it does not seem, from the applications which we find continually made of the instrument, that the simple statement, as commonly given, is sufficiently explicit to prevent a vicious use of this method of experiment. For the measurement and the comparison of the capacities of condensers and similar purposes the ballistic galvanometer is generally reliable, providing the constant is properly determined and suitable appliances used for manipulation. In magnetic measurements, however, it not

unfrequently happens that the duration of the current is much too great, and not only too great, but variable throughout the series of observations, the results of which are compared. The carelessness with which this method of experiment is recommended by authorities who ought to know better is astonishing. We find, for instance, in one of the most widely used text-books on the practical application of electricity the statement that to measure the total induction across the armature of a dynamo a few turns of wire may be wound round the section of commutation and connected in series with a ballistic galvanometer, and the throw of the needle, when the field circuit is closed or broken, will indicate the induction. For any ordinary galvanometer such statements are simply nonsense.

Let us take, for the purpose of illustration, the measurement of the magnetic quality of iron, according to Rowland's method, or some one of the modifications of it which have come into use. Here the specimen is a ring, which, in most of the recent determinations, is made up of wire or thin sheet iron. The ring is surrounded along its whole length by one or more magnetizing coils, and over a short length by a secondary or induction coil, included in the circuit of a ballistic galvanometer. The inductions produced by different magnetizing forces are then measured by observing the corresponding throws of the ballistic galvanometer needle. Various modes of operation are adopted, as, for instance, the magnetizing force is changed by successive steps from an extreme value in one direction to an equal extreme in the opposite direction, and then back by similar steps, thus passing the iron through a complete cycle of magnetization. The corresponding successive throws of the galvanometer needle are then taken to indicate the increased or diminished magnetic induction, due to the different changes of magnetizing force. In another method the magnetization is changed always from the extreme in one direction as the zero for each observation. The change of magnetization is in this case produced either by diminution, and, if necessary, reversal of the magnetizing force in one magnetizing coil, or by the use of a second coil and a current sent through it in such a direction as tends to reverse the original magnetization. The reverse half of the cycle is then obtained by passing the extreme current through the second coil, then slowly decreasing it to the required value, and afterwards suddenly breaking the circuit. The changes of induction are measured as before by the deflections of the ballistic galvanometer needle. Other methods might be mentioned, but these will serve for our present purpose.

In order to illustrate the variable conditions under which such experiments are made, the curves given in figures 1–4 have been drawn by an autographic recorder showing the actual character of the induced current which is sent through the galvanometer under different circumstances. In figure 1 the numbers 1, 2, 3, 4, 5, 6, give the curves of variation of current with time (the ordinate being current and the abscissæ time) for the following set of operations: Two magnetizing coils being placed on the iron a constant current was established in one of them; next, for curve 1, a small reverse current was sent through the other coil; for curve 2, the second coil was closed across the battery and the battery cut out; for curve 3, the battery put in circuit and the current again established; for curve 4, the current was increased by short circuiting part of the resistance in the circuit; for curve 5, the short circuit was taken off and the current reduced to the same valve as at the end of 3; for curve 6, the coil was closed across the battery terminal and the battery taken out of circuit.

Figure 2 shows the result of a similar series with the magnetizing force for curve 1 greater and the operations 2 and 3 of figure 1 omitted. Figure 3 illustrates the result when the whole of the reverse current was put on in operation 1, and the curve 2 shows the effect of short circuiting the battery in the second circuit. Figure 4 is the same as figure 3 so far as the first operation is concerned, but in the operation which gave curve 2 the second magnetizing circuit was simply broken. The scales of these curves are arbitrary, but are the same for the different curves, and hence the relative magnitudes of the changes of current may be estimated from the curves. The reverse current in the second coil was not at any time adjusted so as to give an equal but opposite magetization to that given by the coil through which the constant current was kept flowing. The two primary objects of drawing the curves were (a) to show the great difference in the time required to produce changes of magnetization as depending on the magnitude of the change, and (b) to show the differences in time for the two cases of short circuit and complete break of the magnetizing coil circuit.



The fact that the time required to produce the change of magnetization is dependent on the amount of change shows that, unless the period of the galvanometer needle be so long that even the longest of these times is short in comparison, the measurements of the higher magnetizations will be more in error than the lower. The effect of this on the magnetization curve of iron is to render the steep parts of the curve less steep. The curves 1 and 2 of figure 4 show the effect of the diminished inductive retardation when the circuit is broken in shortening the time required for the magnetization to change back as compared with the time required to produce it. Curve 2 of figure 3 compared with curve 2 of figure 4 shows the relative times when in the first case the e. m. f. is removed, but the circuit left closed and in the other case the circuit is broken. Comparisons between the deflection due to the application and the removal of magnetizing force should always be made in such a way that the circuit has the same inductive retardation in both cases.

The e. m. f. should therefore be introduced and removed without breaking the circuit.

If we assume no damping action on the needle the equation to its motion is

$$\frac{d^2\theta}{dt^2} + n^2\theta = X$$

where n is a constant depending on the galvanometer and the intensity of the magnetic field at the needle, while X depends on the galvanometer and on the nature of the transient current. If we suppose the impulse given to the needle to be due to the charge or discharge of a magnetic field and take the permeability of the core as constant we may put $X = A\ e^{\alpha t}$ where A is a constant depending on the galvanometer and $\alpha = \frac{R}{L}$ where R is the resistance and L the co-efficient of induction.

We thus get $\frac{d^2\theta}{dt^2} + n^2\theta = A\ e^{-\alpha t}$

The solution of this equation is

$$\theta = \frac{A}{n^2 + \alpha^2}\left\{ e^{-\alpha t} + \frac{\alpha}{n}\sin nt - \cos nt \right\}$$

$$\text{or, } \theta = \frac{A}{n^2 + \alpha^2}\left\{ e^{-\alpha t} + \sqrt{\frac{n^2 + \alpha^2}{n}}\sin(nt - \beta) \right\}$$

where term $\beta = \frac{n}{\alpha}$

The constant n is equal to $2\pi/T$, where T is the free period of the needle.

Take, as a particular case, a ring of mean circumference $l = 30$ centimetres, and cross sectional area $S = 2$ square centimetres, and suppose the total number of turns on the magnetizing coil to be $N = 600$, the permeability $\mu = 2000$, and the resistance 1 ohm. Then the increase or decrease of induction per unit current $\times N = L = \frac{4\pi N^2 \mu S}{1 \times 10^9} = \frac{6}{10}$ nearly in henrys. Hence we have α or $R/L = \frac{10}{6}$, and the current at time t, after the removal of the e. m. f., the circuit remaining closed, is $C_t = C_o\ e^{-\frac{10}{6} t}$ where C_o is the current just before the e. m. f. is removed. Giving t different values in seconds we have the following values of the ratio C_t / C_o:

t in seconds =	1	2	3	4	5
C_t / C_o =	0.1889	0.03565	0.00673	0.00127	0.00024

If the resistance be taken equal to 10 ohms then the unit of time in the above table is to be taken as one tenth of a second, and so on for different resistances. Precisely the same calculation applies to the case of increasing magnetization, only C_o is then the final steady current, and the numbers in the line C_t / C_o are the differences from unity of the ratio C_t / C_∞, that is, the equation becomes $C_t / C_o = 1 - e^{-\frac{10}{6} t}$.

Hence, remembering the high value which L may have at certain parts of the cycle in the case of iron, we see that to insure the whole quantity of electricity getting through the galvanometer coil in a small fraction of the quarter period the resistance would require to be in the neighborhood of 1000 ohms for a needle of 4 seconds period, and of 100 ohms for a needle of 40 seconds period.

The quantity of electricity which flows through the coil in time t is given by the equation

$$Q = \int_0^t C_o\ e^{-\frac{R}{L} t} = C_o \frac{L}{R}\left(1 - e^{-\frac{R}{L} t}\right)$$

Hence in the case supposed above the quantity which flows in one second is about $\frac{4}{5}$ of the whole when the resistance is one ohm, and about $\frac{4}{5}$ of the whole in $\frac{1}{100}$ of a second when the resistance is 100 ohms.

The equatim $\theta \frac{A}{n^2+\alpha^2}\left\{ e^{-\alpha t} + \sqrt{\frac{n^2+\alpha^2}{n}} \sin (nt - \beta) \right\}$ reduces to $\theta' = \frac{A}{\alpha n}$ in the case of α being very great in comparison with n and this form can be readily reduced to the equation commonly given on the supposition of the time of discharge being small in comparison with the period of the needle. Keeping to the case taken above of the

period 4 seconds or quarter period 1 second we have the following values of a :—

a =	1	10 / 6	2
θ / θ' =	0.632	0.774	0.810

The middle one of these values corresponds to the ring discussed above when the resistance is one ohm. In these three cases the maximum deflection is reached after 1.54 seconds, 1.45 seconds and 1.40 seconds from the time when the e. m. f. is applied to or removed from the circuit. The conditions here taken may be considered extreme in so far as the period of the needle is concerned, but it is not difficult to find examples of actual measurements in which the period has been equally short.

The examples here given are probably sufficient to direct attention to the care that must be taken in the choice of apparatus and the arrangements of circuits when the ballistic galvanometer is used in magnetic measurements. The method is only applicable when a is so large that θ and θ' are practically equal to each other and this condition is approximated to by making R large and L as small as possible. Hence, high e. m. f. s. should be used with high non-inductive resistance in the circuit and magnetic force should be secured with small numbers of turns by using large currents. It is well always when comparing charge with discharge to keep the induction of the circuit the same in both cases by means of an apparatus which cuts out the battery and at the same time keeps the circuit closed through an equal resistance, instead of breaking the circuit when the discharge is measured. A check on the accuracy of the observations in any particular case may be obtained by observing the successive extreme deflection of the needle. If the first deflection has the proper magnitude the mean ordinate of the curves drawn through the extreme deflections to opposite sides of zero should be at all points zero. When the duration of the current is a large fraction of the time of swing of the needle the mean of the deflections to opposite sides will lie for the first few swings on the same side of zero as the initial deflection.

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THE SCIENTIFIC METHOD AND MODERN INTELLECTUAL LIFE.

SCIENCE, as a necessary term, is possibly upon the verge of obsolescence. Within the last half-century it has spread the mantle of its meaning over almost every department of thought until to-day knowledge and science are perceived to be so nearly coextensive that the newer term might rightly yield to the priority of the older. While twenty-five years ago one heard much about science and the languages as rival claimants for place in the college curriculum, one now listens to the message of that useful *science*, classical philology. Then the polemic between science and religion seemed earnest indeed; now theologians and laymen are alike shocked when Mr. Benjamin Kidd suggests that there can not be a science of religion. Antithesis has softened into synonymy. It is not that the lion of science has devoured the lambs of art, literature and philosophy; it is rather that systematists of opinions and beliefs have determined a generic unity where before variety was supposed eternally to exist. Such condition has arisen, it may be presumed, from the prevalence at least among Western nations of what has come to be denominated the scientific method. This prevalence is not yet universality. It does not yet extend in full measure to every individual; nor does it, perhaps, persistently characterize the intellectual life of any man at the present time. The atavism of superstition must somewhere mar the image and superscription of one's intellectual inheritance. Nevertheless, so widespread and so dominant

everywhere is this scientific method that in a broad sense it might be accorded universality. It becomes, then, an important matter to discover, if one can, what effects upon the intellectual life, not only of the individual, but of society in general, are resulting from the method now and will develop in the future.

It is possible to define science as that orderly mass of facts and hypotheses within experience by which we criticise our primitive ideas. Social, not merely individual, experience and the broader implication of criticism are intended. The scientific method is therefore that intellectual process by which facts are recognized, accumulated and arranged, hypotheses framed, tested and exploited and conclusions drawn, verified, accepted and applied where they may seem best to fulfil their function in the enginery of social progress. It would be an error to suppose that any clear demarcation exists between knowledge that is scientific and other knowledge that is not; nor can one, search as he will, discover the birth-place or learn the natal day of the scientific method. As Dr. Osborn has shown, from the Greeks to Darwin there exists a continuity of speculative evolution. Bacon was not the first to make use of induction. Franklin did not discover electricity, nor Lamarck the impermanence of species. Everywhere the older phases of thought merge into the newer, much as one picture seems to follow another in the cunningly presented dissolving views or phantasmagoria of the stage. Yet it will scarcely be gainsaid that while yesterday the scientific method was indeterminate and sporadic, to-day it is definite, characteristic of most that is valuable in thought and in a sense universal.

Carrying farther the definitions which are so useful if one desires to make one's meaning plain, it will appear that the intellectual life is a concept that has enlarged, imperceptibly at first, but surely during these later days. When one sees the phrase in type one does not stop with Hamerton. Insensibly the meaning of the word *life* has expanded in the minds of thoughtful men until the limits of individualism are instinctively transcended and the instant idea is of the greater social, not of the lesser individual organism. No more impressive evidence of an onward movement in thought could be offered, no more conclusive demonstration of some welding, humanizing force unconsciously at work generalizing and extending the point of view. The intellectual life is seen to be not merely an efflorescence of culture; it is not the knowing of the best that has been said and written in the history of the world; it is not the peace of introspective calm, nor serenity in a delightful oasis amid the desert sands of a crass and insentient materialism; it is a strenuous, an austere exertion of those high human powers that command the world of things for the world of thought. Culture, essentially individualistic, is not the concretely social and dynamic intellectual life. It is true one must not altogether forget the traditional meaning of the phrase, but that traditional meaning is after all suggestive principally as a vestigial character. Its peculiar interest lies in the fact that it has been outgrown.

Having indicated the content of such phrases as *intellectual life* and *scientific method*, it remains to show briefly how the latter in its slow but massive development has influenced the former, or rather how the two have unfolded themselves in unison. In the course of the examination, it will perhaps become apparent that the larger modern implication of such a phrase as *intellectual life* is due, above all, to precisely such influences as have been brought to bear upon the texture of society by the progressively larger, though in great part unconscious, activity of what has been termed the scientific method.

Noting first the evident contact points,

especially in pedagogics, between the scientific method and the intellectual life of the individual, one cannot but reaffirm in the light of experience what has long been maintained by those who advocate the fundamental position of science in every educational system. In the domain of reason, breadth, grasp and clarity are developed as under no other discipline. Sanity in emotion is secured, and vigor, together with modesty and a reasonable deliberation, tends to distinguish the active life of the man who has brought himself into what may be styled a scientific frame of mind. The accumulation of any mass of facts, if the search be tireless, must stimulate the growth of a certain cosmopolitanism. The Scarabean doubtless found more foreign letters in his mail than did the Autocrat. When one goes farther and attempts an induction or an hypothesis he must hold firmly the facts he has, his eye must be unclouded, his step steady, or he will fail. Still more certainly will his office remain an humble one if, when he ventures to make known to others his discoveries or conclusions, he want in transparency and precision. Nor will the man whose life is truly illuminated by the sun of science lack somewhat of self-control; under less favorable conditions this equipoise may take the guise of unenthusiasm, but at its best it is activity —sympathic, tolerant, enlightened. Such being their recognized educational productivity, the so-called sciences have taken masterful positions in the schools of Europe and America. It will not be necessary here to point out in detail the precise pedagogic adaptability and the importance of the various sciences in a general educational scheme; it will suffice to inquire whether it be not true that whatever branch of learning popularly classed outside of the sciences maintains itself in school curricula, it does so by virtue of the scientific method being possible in its presentation.

Although clearly not so fundamental in their effect upon the individual character as must be these simple reactions where the scientific method is brought into an alembic with nascent intellect, there are some relatively subtle yet far-reaching influences that should not be overlooked. From a number that might be chosen I will bring forward three. A just appreciation and personal application of the scientific method tends to discourage introspective and metaphysical habits of thought, to counteract the insidious pessimism with which so much of modern life is tinged, and to impel one unmistakably toward a rational and sober altruism. I would not be understood to regard metaphysics as altogether pernicious. At its worst it may be as Walter Pater thought it, 'the art of methodically muddling one's self,' but it has its place and its mission. Yet there is an individualistic and almost a selfish tendency in much of what passes for philosophy. One need not pursue the thorny path of dialectics to the end that one denies the existence of all but himself. Whatever intellectual attitude demands, an attentive scrutiny of one's own mental, moral or physical mechanism can not but be self-centered. For this reason, if for no other, the failure of deductive philosophy to carry its influence beyond the lecture room or seminarium might easily have been predicated in advance. The student of the history of philosophy is scarcely more impressed by the cumulative intricacy of philosophic speculation than by its progressive futility as a guide in the every-day affairs of life. Employment of the scientific method discourages on the whole that naive self-inspection which was the badge of the older intellectual *cultus*, just as on the other hand it lends encouragement to the open-eyed, outward searchings of the modern investigator. This objectivity, whether or not it be an indication of intellectual maturity in a nation, is distinctly charac-

teristic of modern Occidental civilization in no less degree than the reverse condition is supposed to mould the thought and life of the Orient. Such objectivity—not without the stigma of materialism—seems to result from the general prevalence of the scientific methods in contemporaneous thought.

If it be protested that the scientific method is blighting in its tendency to suppress metaphysics, not so certain objections will be made to its efficiency as a counterfoil against philosophic pessimism. Whether one professes with Schopenhauer to believe that this is the worst possible world, or joins von Hartmann in that more dismal suggestion that this is the best possible world, but not worth living in; whether one sigh with De Musset, weep with LeConte de Lisle, or rave with Baudelaire, one must give the sanction in so doing to existence, and if to existence then to evolution, by which such existence became possible, and if to evolution then to progress. Therefore, if we have the scientific spirit two escapes are possible from the darkness of pessimism—superficially by occupying one's self with some scientific protocol, or more profoundly by turning one's despairing thoughts aside in the recognition of an indwelling power in the social organism which makes, if not for righteousness, at least for social evolution. If under the leadership of the scientific method one can actually grasp the form of truth there is in positivism; if one can really feel the existence of a social organism and listen to his ideals as did Comte, believing them to be the sealed orders of humanity; if one can learn with Weismann to know the profound sense in which all men are brothers, *for all men are one*, it will make little odds to him whether he be shown with most convincing logic that the constitution of the nervous system makes pain the positive and pleasure the negative and that death is merely an acquired physiological trait useful to insure the permanence of the species at the zenith of its youth and power. But after all, perhaps the most fatal blow that the scientific method strikes to pessimism is, as argued above, in its settled antagonism to introspection. For pessimism as an ethical and metaphysical system is based peculiarly upon self-observation. A man does not despair of the world from what he sees around him, but from what he sees in the secret places of his own heart. By its discouragement of morbid subjectivity the scientific method cuts the very foundation from under the philosophic pessimist.

We are led then to the third postulate—that the scientific method impels us unmistakably toward a rational and sober altruism. This indeed links itself inseparably with the others. If defective this type of altruism is defective in fire and in enthusiasm. Domination by the calm reasonableness of the inductive philosophy does not stimulate one to take up the tambourines and drums of the Salvation Army. He who has ordered his mental processes in accordance with a scientific method is inclined to prefer the charity organization to personal alms-giving; he shrinks a little from the zeal of the social reformer; he is unlikely to be a poet in literature, a rhapsodist in music or a revivalist in religion. He is rather to be sought among the rank and file of the great, silent army which is behind every reform as 'public sentiment' or as the 'moral sense of the community.' But as has been pointed out elsewhere this quiet acquiescence is a necessary factor in social reform, just as underneath every successful revolution there has been a subtile and tacit confession of faultiness in the established order by the very party that storms barricades in the struggle for its maintenance. To sum it up in a word, under the scientific method men may not be so ready to conquer rights and privileges for others, but they are prepared unflinchingly to con-

cede such rights when the request has come with authority.

From this point the transition is easy to the consideration of what influence the scientific method may exert in a general way upon society as a whole. There is not space in the compass of a review article to discuss adequately a matter of so many complications, but it is possible to offer a syllabus for reflection. It must first of all be kept in mind that *world-wideness* is in the fabric of all sceince. Since induction is objective, the scientific method is cosmopolitan. The humble describer of a new species of butterfly must have passed, in orderly fashion, all the butterflies of the earth before his mind ere he ventures to set his own over against the rest as new. The question of the German University laboratory—'Was haben Sie neües gefunden?'—presupposes a knowledge of what the world has done before. This characteristic of the scientific method cannot be too strongly emphasized. What then must be the natural reflex of the method upon social institutions?

Science has bound the world together by its spirit no less than by its discoveries. Interest in others would make communication easy even if the telegraph did not exist. Sympathy is a stronger cable than those that lie along the bottom of the Atlantic. Hence in every region of human intellectual activity one traces the broadening influence of the scientific method. In politics, democracy; in warfare, humanity; in commerce, freedom; in art and in literature, realism; in all the social relations of life, kindliness and charity; in religion, tolerance and dynamic helpfulness—these are the children of this scientific method. Perhaps nowhere better than in the field of religion has the change to the new order made itself felt. Religion is to-day recognized as social rather than as individual. Faith is blended in works, and in place of a pitiful solicitude for the welfare of one's own immortal soul there has been developed a missionary spirit, boundless in its self-sacrifice, a magnificient phenomenon of altruism. It is very remarkable when comparing theological literature of say the Oxford Tractarian movement with that of the present decade, such as the discourses of Washington Gladden or the Unitarian writings of Martineau, to note that the essential difference between the two groups is that in the former everything is discrete and individualistic in tone, while in the latter everything is concrete and social. Under the stress of the scientific method, sanctity has seemed second to helpfulness, just as individual culture has seemed a less noble end than social progress.

On the whole the influence of the scientific method upon society is two-fold. Statically it has added organizability to the social character, and by virtue of this it has dynamically contributed to the advance in social progress. The influence mentioned upon character could scarcely strike more profoundly, for the capacity to take part in organization is possibly the most important trait of all in social character. Precisely as organization becomes most perfect will progress be most rapid. And here one perceives that a veritable intellectual sanction for progress is to be sought. The author of *Social Evolution* has denied that such sanction exists, but apparently without taking into account the very method by which he arrived at this conclusion. There is quite as strong an instinctive quality in science as in religion. Each takes progress for granted, each in its own field contributes to the advance, and in so doing each gives its sanction to the movement. Since progress lies principally within the realm of the social organism, its sanctions are social rather than individual. And the error has been in failing to perceive the strong social nature of a certain type of intellection

and in assuming the metaphysical or introspective type to be the only one worthy of consideration. In the phrase 'devotees of science' there is a gleam of true meaning, for in its social quality, its instinctiveness, science is akin to religion. One might term science an intellectual religion and not go wide of the mark. While it may be argued that philosophy in the traditional sense does not sanction progress, it cannot be argued that science withholds either sanction or its encouragement. Science is social thought reflected back into the mind of individuals; metaphysics is individual thought radiated outward upon society. The sanction for social progress is therefore derived rather from society as a whole than from individual introspection. For this reason the intellectual sanction is all the more forceful and takes its place beside the moral sanction offered by religion. There need then be no fear that progress is intrinsically irrational, and there may be a science of religion, as there is a religion of science. It is the function of the scientific method to organize for victorious contest the battalions of the intellect, while religion may bring on the moral forces. Therefore it appears that progress is an open-minded movement onward, of which we are all a part, and to which reason, under the sway of the scientific method, gives sanction no less than does emotion.

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THE LIQUEFACTION OF GASES.—A CONTROVERSY.

THE scientific world has been treated during the last few weeks to one of those happily to-day rather infrequent controversies which are always unseemly, the more so when the parties are men of eminent scientific reputation. Polemics in science may sometimes be entertaining, but are always unprofitable and tend to bring discredit upon the participants, if not on their work. The recent discussion* on the subject of liquefaction of gases is no exception to the rule.

Prof. Dewar, in defending his failure to give Prof. Olszewski due credit, has made what might have been looked on as a pardonable omission appear almost as intentional deceit. In taking up the cudgels in Prof. Olszewski's defense, Professor Muir has seemed to make an unjust and almost spiteful attack upon Professor Dewar; while Professor Olszewski, whose work was already too well and favorably known to need any defense, has added nothing to his reputation; indeed, he has rather laid himself open to the charge he prefers against Professor Dewar, inasmuch as in his article in the Engineering and Mining Journal he makes but slighting reference to the work of Pictet and Cailletet, and the name of Wróblewski is but once, and that incidentally, mentioned. The following is a summary of the more important work of these investigators in this field:

In 1877 two independent experimenters almost simultaneously succeeded in condensing to liquids the so-called permanent gases. Cailletet, the French ironmaster at Chantillon-sur-Seine, used a hydraulic press, and obtained the necessary lowering of temperature by suddenly diminishing the pressure on the compressed gas. A mist appears in the glass tube containing the gas, and, except in the case of hydrogen, condenses to small drops. Pictet, at Geneva, used the pressure occasioned by the generation of the gas in wrought iron cylinders, and cooled his steel condensing tube with liquid carbon dioxid. In experimenting with hydrogen, Pictet obtained an opaque steel blue liquid, which appeared to solidify

*On the Liquefaction of Gases. Charles Olszewski, James Dewar, M. M. Pattison Muir, *Nature*, Jan. 10, 1895, and following numbers. Letters to the Editor. Also in *The Philosophical Magazine.*

on striking the ground. Later researches of Olszewski and Krzyzanowski have shown that this liquid could not have been hydrogen, and that the gas obtained, as Pictet's was, from potassium formate and caustic potash is by no means pure hydrogen. To Cailletet and Pictet belongs the credit of being the pioneers in this field, and to them in 1878 was awarded the Davy medal of the Royal Society.

A few years later (1883) the work was taken up by Wróblewski and Olszewski at the University of Cracow, and after the death of the former in 1886 was carried on by Olszewski alone, and more recently by Olszewski and Witkowski. The apparatus used was derived from that of Cailletet, the production of cold being by the boiling of liquid ethylene in a vacuum.

The aim of Olszewski's researches has been the exact investigation of the properties and conditions of matter at low temperatures. Many physical constants of the so-called permanent gases have been determined, and especially the optical properties of liquid oxygen have been thoroughly studied. More recently Olszewski was entrusted by Lord Rayleigh and Professor Ramsay with the liquefaction of Argon, and the results of this investigation have been widely published. His latest work is the determination of the critical temperature (—233°) and the boiling point (—243°) of hydrogen, the last gas which still resists condensation to a static liquid.

Professor Dewar, in his position at the Royal Institution of Great Britain, has been looked upon, perhaps, rather as a public lecturer and brilliant experimenter than as an exact investigator. In 1884 he delivered an address at the Royal Institution on the work of Wróblewski and Olszewski, during which oxygen and air were liquefied for the first time in public. He later so improved the apparatus, which was founded on the principles used by Cailletet and by Olszewski, that he could obtain with safety and without great difficulty very considerable quantities ('several pints') of liquid oxygen or air, and his public experiments with this liquid are famous. By the use of liquid air he has studied the electrical resistance of metals and alloys at low temperatures, extending greatly the work of Clausius, Cailletet and Bouty, and Wróblewski in this direction, and has undertaken work on the tension of metals at low temperatures. As far as these latter experiments have been carried, they seem to show that the breaking stress of metals increases decidedly at low temperatures (—182°) and hence that there is no decrease of molecular attraction as absolute zero is approached, although the most powerful chemical affinities are in abeyance, as Professor Dewar has shown. He was also the discoverer of the magnetic properties of liquid oxygen.

In his earlier work Professor Dewar certainly did not fail to give Professor Olszewski due and full credit. Of late years he has failed to often refer to him, and the charge that he has sometimes apparently claimed as his own that which he should have attributed to the Polish professor is, perhaps, not wholly unfounded; yet the claim of the latter for priority was so well understood by scientific men that his attack on Professor Dewar was at least unnecessary. That the Englishman, possibly somewhat rankled that his countrymen should have called on a foreigner to assist in their study of Argon, was led to make a spirited rejoinder, to pose as more of an independent investigator than the facts warrant, and to depreciate the work of his opponent, is perhaps not to be wondered at, but certainly not to be excused. Altogether the discussion is profitless and unfortunate.

JAS. LEWIS HOWE.
WASHINGTON AND LEE UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY (VIII.).

A SPELÆOLOGICAL SOCIETY.

OF course, everybody knows what spelæology means—or perhaps there are one or two who do not, considering that the word was manufactured only last year. Its sponsor was M. E. A. Martel, a French scientist distinguished for his numerous and skillful explorations of caves for scientific purposes. In Greek *Spelœus* means a cave, and 'spelæology' is the science of cave-hunting,as it was called by the English. A society has been formed in Paris with that as a specialty, concerning which the curious inquirer can learn more if he addresses M. Martel, No. 8. Rue Menard.

The subject is one richly deserving this kind of concentrated and special study. No localities preserve more perfectly the records of the past than caverns. In their darkness and silence, guarded by their massive walls, layer after layer of deposits have been strown by their occasional visitors, by inundations and by percolation. A stalagmitic floor, clean, hard and imperishable, seals the traces of every occupant in perfect preservation through all time. Some of the most important discoveries in geology and archæology are due to these conditions. I need but mention the labors of Lartet, Christy, Boyd Dawkins, and in this country of Cope and Mercer, to attest this.

But nowhere is ignorant excavation more fatal than in cave-deposits. There is a high science in their examination; and M. Martel has planned an admirable scheme to disseminate valuable instruction on this essential point.

A VALUABLE STUDY IN PRIMITIVE ART.

A STUDY in primitive art of the most satisfactory character has been lately published by the Royal Irish Academy. It is entitled 'The Decorative Art of British New Guinea: A Study in Papuan Ethnography,' by Alfred C. Haddon, M. A., Professor of Zoölogy in the Royal College of Science, Dublin. The author approaches his topic with an extensensive personal knowledge of it, and a thorough appreciation of its bearings on the leading questions of ethnology in general. The memoir is in large quarto, with twelve full-page plates and many cuts inserted in the text. Some of the designs are colored, and all are copied with fidelity and clearness. Their variety is astonishing, considering that we are dealing with the art of cannibalistic savages, and the sense of proportion and harmony often manifested is just and real. The rapid development of conventionalism is evident, and even in such primitive examples one soon loses the traits of the original design. This has often been commented on in American aboriginal art.

Professor Haddon corrects the impression which sometimes prevails, that art decoration, for itself, is unknown to savages. Art is related to ease; as he says, 'Art flourishes where food is abundant.' Another vital conclusion he expresses in these words: "The same processes operate on the art of decoration, whatever the subject, wherever the country, whenever the age, illustrating the essential solidarity of mankind." No truer words have been spoken on the subject, and ethnographers should learn them by heart.

In every respect the memoir is most creditable to the writer and to the institution which publishes it.

D. G. BRINTON.
UNIVERSITY OF PENNSYLVANIA.

JAMES EDWARD OLIVER.

ON March 27th, 1895, after an illness of ten weeks, died Professor J. E. Oliver, of Cornell University, universally honored and beloved.

For more than twenty years he has been at the head of the department of mathematics in this great institution.

Born in Maine in 1829, even from his graduation in 1849 he ranked as a mathematical genius, one of the most remarkable America has produced. But he seemed to have no ambition to leave an adequate record of his mental life in print. In personal character he resembled Lobachévsky, whom he intensely admired.

He was spontaneously loyal to the good and the true, enthusiastic, thorough, painstaking. He loved poetry ; he loved Shakespeare; he was averse to religious creeds. For Professor Oliver goodness was spontaneous. He did the right not because it was right, but because he intensely wished to do just that. The spring of action seemed a combination of sympathy, perception, knowledge, scientific logic.

In mathematics Professor Oliver worked for the love of it and because he was deeply convinced that mathematics affords that fine culture which the best minds seek for its own sake.

He was a pronounced believer in the non-Euclidean geometry.

I vividly recall how he came up after my lecture on Saccheri at Chicago, and expressing his interest in the most charming fashion, proceeded unhesitatingly to give me a profound lecture on stellar parallax, the measurement of the angles of astronomical triangles and the tests of the quality of what Cayley called 'the physical space of our experience.'

Again, after the Brooklyn meeting of the American Association, he took up the same subject with me, explained a plan for combining stellar spectroscopy with ordinary parallax determinations, and expressed his disbelief that C. S. Pierce had proved our space to be of Lobachévsky's kind, and his conviction that our universal space is really finite, therein agreeing with Sir Robert Ball.

GEORGE BRUCE HALSTED.

UNIVERSITY OF TEXAS.

JAMES DWIGHT DANA.

WE take from the authorized account by Professor Edward S. Dana, in the May number of the *American Journal of Science*, the following facts concerning Dana's life. He was born in Utica, N. Y., on February 12, 1813, his father and mother being from Massachusetts. He early showed an interest in natural history, which increased during his course at Yale College from 1830 to 1833. Immediately after graduation, Dana spent fifteen months as instructor in mathematics to the mid-shipmen of the United States Navy, the time being passed in the Mediterranean. He then spent two years at New Haven, being part of the time assistant in chemistry to Benjamin Silliman. The four following years were spent with the exploring expedition sent by the government of the United States under Wilkes to the Southern and Pacific Oceans. The following years were devoted to the study of the material collected. In 1844 he married a daughter of Prof. Silliman, who survives him, and in 1846 became associated with him in the editorship of the *American Journal of Science*. In 1850 Dana was made professor in Yale College. The remainder of his life was spent as teacher, editor, author and investigator.

Dana was President of the American Association for the Advancement of Science in 1852, and was one of the original members of the National Academy of Sciences ; he received the Wollaston Medal of the Geological Society of London, the Copley Medal from the Royal Society, and the Walker Prize from the Boston Society of Natural History. He received honorary degrees from the University of Munich, Edinburgh and Harvard. He was a member of the Royal Society of London, the Institute of France, the Royal Academies of Berlin, Vienna and St. Petersburg, and many other societies.

In addition to a large number of papers

printed in the *American Journal of Science* and elsewhere, he is the author of the following works:

A System of Mineralogy, 1837, 1844, 1850.

Zoöphytes, 1846.

Manual of Mineralogy, 1848, 1857, 1878, 1887.

Coral Reefs and Islands, 1853.

Crustacea, 1852–54.

Manual of Geology, 1862, 1874, 1880, 1895.

A Text-Book of Geology, 1864, 1874, 1882.

A System of Mineralogy, 1868.

Corals and Coral Islands, 1872, 1890.

The Geological Story Briefly Told, 1875.

Characteristics of Volcanoes, 1890.

The Four Rocks of the New Haven Region, 1891.

CORRESPONDENCE.

THE EDUCATION OF THE TOPOGRAPHER.

TO THE EDITOR OF SCIENCE: Part of Professor Merriman's review in SCIENCE for April 26 interests me as being the direct opposite of my own opinion. He says, apropos of Mr. Gannett's statement that the topographer must be able to generalize through his knowledge of geological processes: "These are dangerous doctrines. The earth exists, the duty of the topographer is to map it truly, and the study of the origin of its features should come later." I should like very much to learn through the columns of SCIENCE the opinions of other geographers and topographers on this question.

It is not alone the earth that exists; a large series of topographical maps of various parts of the earth also exist; and through their study the young topographer can learn much about the kind of work he will have when surveying those separate parts of the earth that are not yet mapped. This kind of knowledge will help him in mapping new regions in about the same way that preliminary study of known forms of plants and animals helps the systematist to describe new forms when he finds them.

It is certainly the duty of the topographer to make true maps; but the truest map is always only a generalization. Something is necessarily omitted, and the topographer has to choose between what he shall omit and what he shall represent. He sees many things that he can not map. How shall he be best aided in making on the small sheet of paper before him an expressive map of the broad surface of country around him? I do not say 'an accurate map,' because the word 'accurate' is so generally misunderstood in this connection. It is often taken to imply that the topographer has actually measured every part of the surface of the country and carefully constructed every line on his paper. As a matter of fact, by far the larger part of all maps is sketched, and in the sketching more facts often have to be omitted than can be represented. Hence, everything should be taught to the topographer that will aid him in really seeing the facts that are before him and faithfully representing such of them as come within the limit of the scale he employs.

Nothing is of more assistance in seeing the facts, and in thus making a good beginning towards sketching them properly, than some understanding of their origin and meaning. Hence I believe that the best course of education for topographers while yet in school should include a careful study of the development of land forms, and that the best practical work by topographers will require a very careful and sympathetic study of the origin of the land forms on the ground before him. The prepossession that contour lines bend up-stream has deceived many a topographer into giving a wrong expression to flat alluvial cones. Indifference to the significance and importance of the sharp edge of a gorge or a cliff

has rounded off many a truly angular contour line into an inexpressive curve.

The objection that is sometimes made against this view of a topographer's education and work is that, if he tries to sketch what he thinks he understands, he will sometimes sketch what is not really before him. There may be a certain amount of truth in this, but there are sufficient answers to it. A topographer who is too far guided by his imagination has been badly taught, or else he is of a mental quality that will prevent his ever becoming a good topographer, quite apart from whatever education he has had. The well taught topographer will make no larger share of mistakes on account of being well informed on his subject than will the well taught systematic botanist or zoölogist. The few mistakes of interpretation that the well taught topographer may make will, I believe, be far outweighed by excellence of the other part of his work.

It is perhaps because I have a higher idea of a topographer's work than ordinarily obtains that I should like to see him generally better educated for it. To my mind, a map is so far from being a copy of nature that I should prefer to call it a graphic description of nature, and in the making of this graphic description the topographer should study his subject and his graphic signs with the same care that a writer should study his thoughts and the words he employs to represent them. Instruments, to which some topographers seem to give their first attention, ought to have about the same place in their real work that a typewriting machine has in the work of a literary man.

The chief subject of the topographer's study should be the form of the land before him; and until this is recognized in engineering schools and enforced by a careful course of preparatory physiographical study, I believe we shall not have the best maps that can be made. Even further, it is as impossible to make a good topographer by merely teaching him about plane tables and stadia and logarithms as it is to make an essayist by teaching him about writing and spelling. It seems to me, in fine, that Professor Merriman's interest in the mathematical aspects of the art of topography leads him to place too low a value on the importance of studying the chief subject of the topographer's attention, the forms of the land.

W. M. DAVIS.

CAMBRIDGE, MASS., April 30, 1895.

THE HELMHOLTZ MEMORIAL.

A FEW months ago Hermann von Helmholtz died, one of the greatest scientific geniuses of all time, whose name will not be forgotten as long as men care for the knowledge of Nature. His invention of the ophthalmoscope made the success of the modern oculist possible; his papers on the conservation of energy gave the strongest impulse to modern physics; his books on seeing and hearing became the basis of modern psychology.

It seems a matter of course that the present generation should express its gratitude in a lasting monument. Not only his friends and pupils all over the world, but men of science and physicians everywhere have supported this idea, and so last month an International Committee was formed to collect money for the erection of a great Helmholtz monument in Berlin, where for the past twenty-five years he lived and worked. The plan has nothing to do with local patriotism; America, France, England, Italy and Russia are represented on the Committee; not a decoration of the city of Berlin is in question, but a universal expression of devotion to the spirit of natural science.

No doubt America will take a very high place in the list of givers. There has been seldom such an opportunity to show that the United States does not stand behind any

other country in intellectual interests. But America has a special reason for paying her respects to the genius of Helmholtz, since Helmholtz in his seventy-second year paid his tribute of respect to the genius of America. One year before his death he crossed the ocean to study and to enjoy the scientific institutions of this country from the Atlantic to the Rocky Mountains, certainly the most famous European who has visited America for many years, and nobody who saw his noble personality in New York or Boston or Baltimore, in Philadelphia or Washington or Chicago, will ever forget him.

The American members of the International Committee are Dr. Wolcott Gibbs, President of the National Academy of Sciences; Dr. Herman Knapp, Professor of Columbia College; and Dr. Hugo Münsterberg, Professor of Harvard University.

Contributions may be sent before May 25th to the undersigned Secretary and Treasurer of the American Committee. The lists of contributors will be published weekly in SCIENCE.

HUGO MÜNSTERBERG.

38 QUINCY STREET, CAMBRIDGE, MASS.

SCIENTIFIC LITERATURE.

Manual of Geology. By JAMES D. DANA. Fourth Edition. American Book Co. 1895.

The announcement, a few months ago, of a new edition of Dana's Manual filled geologists with liveliest expectations. It is needless to say that these expectations are more than realized. The Manual is so well known that a full account is wholly unnecessary—geologists need no urging to buy it. They simply must have it; they cannot do without it. I write this, therefore, not to call attention to the book; but partly because I am glad to have this opportunity to express my unstinted admiration for the author and for the book; and partly because I wish to draw attention to the author's position on some important questions which have come into prominence since the last edition.

1. Every geologist will be gratified to see that the author now comes out frankly for evolution; not, indeed, evolution in a materialistic sense, but in a reverent, theistic sense. In a certain Agassizian sense he has always been an evolutionist, but he has been often quoted by the *opponents* of evolution as now understood (*i. e.*, 'origin of organic forms by descent with modifications') as sustaining their position. In this edition his utterances are not to be any longer mistaken; although he is, perhaps, more nearly Lamarckian than Darwinian, or, at least, than Neo-Darwinian. Surely such plasticity and open receptiveness of mind retained even to the very last is a noble evidence of the true scientific spirit.

2. In this edition he separates the Palæozoic into two primary divisions with *Eo-Palæozoic*, including the Cambrian and Lower Silurian, and the *Neo-Palæozoic*, including the Upper Silurian, Devonian and Carbonic. Thus he makes the greatest break occur between the Lower and Upper Silurian. If this be so, would it not be better to use Lapworth's term 'Ordovician' for Lower Silurian, retaining the term Silurian for the Upper Silurian alone? Probably this would violate the priority-rule of nomenclature; but, perhaps in this, as in many other cases, rules too strictly interpreted stand in the way of a rational classification.

3. He accepts the probability of a Permian glaciation, especially in the Southern Hemisphere; and of an elevation and enlargement of an Antarctic continent and its connection with the southern points of South America, South Africa and Australia as a cause of such glaciation. These great changes of physical geography and climate, and consequent wide migrations of faunas and floras, would go far to account for the

enormous and apparently sudden changes in organic forms which took place during and at the end of the Permian period.

4. In connection with the last he accepts also the idea of a land-connection (Gondwanaland) between *India and South Africa*, and perhaps indirectly through the enlarged Antarctic continent—with Australia —in Permian and Triassic times, as evidenced by the great similarity of the plants and the reptiles of that time in these now widely separated countries. It is true that there is very deep sea between these points now; but it is possible that the idea of the permanence of deep sea basins, originated by Dana, may have been pushed a trifle too far by Wallace as a means of separating faunas and floras.

5. He does not accept Algonkian as a system of rocks coördinate with Palæozoic and Mesozoic, but regards these pre-Cambrian strata as the upper part of the Archæan, *i. e.*, as Huronian and upper Laurentian. Perhaps the time is not yet come to settle this question definitely.

6. He accepts as probable the existence in Quaternary times of a greatly elevated and enlarged Antarctic continent, connecting with and connecting together the southern parts of South America, South Africa and Australia similar to that of Permian times, as evidenced by the faunas, and as accounting for the Quaternary glaciation of these regions.

7. He agrees with Hilgard in thinking that the LaFayette formation (many geologists seem to forget that we owe this name to Hilgard) is a torrential *river* deposit of the early Quaternary and not a *marine* deposit of the Pliocene times as maintained by McGee, and that therefore it indicates elevation and not depression of the continent.

8. He does not accept Croll's theory of the cause of the glacial climate; but, along with most American geologists, regards it as mainly due to elevation of northern land. This would not only directly increase the cold in high latitude regions, but would indirectly increase the ice-accumulation by connecting America and Europe in these regions and thus limiting the northward extension of the Gulf Stream, which, circulating around the Atlantic in mid-latitude regions, would furnish abundant warm vapors to be condensed as snow on the elevated northern land.

9. As might have been expected, his discussion of mountain-making is masterly. But one is interested, though not surprised, to observe that he does not accept the recent theories of Reade, Dutten and others as to the cause of mountain formation, but still regards the *contraction-theory* in some form as more probable.

But a reviewer is 'nothing if not critical.' I must vindicate my character as reviewer by finding some faults, even though they be trifling.

10. This edition, we observe, drops out the graphic illustrations of the distribution, in time, of families, orders and classes of animals, which constitutes so conspicuous, and, we may add, so attractive a feature of previous editions. We observe also that the index of authors quoted and of those from whom figures are taken is omitted. This is to be regretted in a work which will be so constantly referred to.

11. We observe also a few errors of oversight or of misunderstanding of authors quoted. On page 359, and again on page 380, he gives, on King's authority, the whole thickness of Wahsatch sediments, from the Cambrian to the Laramie inclusive, as 31,000 feet. In fact, King gives between 31,000 and 32,000 for *the Palæozoic alone*, page 122; and in addition 3,800 feet for Jura-Trias, page 537, and 12,000 feet for the Cretaceous, page 539 (49th parallel, Vol. 1).

Again, he states on page 520 that the oldest known insect—*Protocimex*—is found in the

upper part of the *lower* Silurian; but on page 566 he says that the oldest known insect is the *Palæoblattina* of the *upper* Silurian.

We might mention others, but they are all trifling. In fact, the accuracy of the book is extraordinary.

In conclusion, we must heartily and most gratefully welcome the new edition. It is hard to say what American would be without Dana's Manual. Its encyclopedic fullness and yet extreme conciseness makes it hard reading for those who come to it without serious purpose. The word '*Manual*' exactly expresses its purposes and uses. It must be in the hands of every special student; it must lie on the table of every teacher of Geology to be consulted on every subject of doubt.

I had just finished this notice when the sad news of Dana's death was flashed across the continent. All recognized that this event could not be long delayed; but none the less it came as a shock to every man of science in the country. We are thankful that he lived to finish this new edition, for it is indeed the only fitting monument. No monument is worthy of a man of science except that which he erects for himself.

JOSEPH LE CONTE.
UNIVERSITY OF CALIFORNIA.

A Handbook of Systematic Botany. By DR. E. WARMING. Translated and edited by M. C. POTTER. 8vo. pp. 620, fig. 610. London, Swan, Sonnenschein & Co. New York, Macmillan & Co. 1895.

This excellent English translation of Professor Warming's important work will be welcomed by all students and it cannot fail to have a wide use as a text-book. The descriptions of the groups are clear, concise and complete, the illustrations capital and many of them original, and the press-work leaves nothing to be desired.

The arrangement of groups is from simple to complex—the only arrangement compatible with our present knowledge. The special application of this principle may be best stated in Dr. Warming's own words as printed in the preface:

"Each form which, on comparative morphological considerations, is clearly less simple, or can be shown to have arisen by reduction or through abortion of another type having the same fundamental structure, or in which a further differentiation and division of labor is found, will be regarded as younger, and as far as possible, and so far as other considerations will admit, will be reviewed later than the 'simpler,' more complete or richer forms. For instance, to serve as an illustration: EPIGYNY and PERIGYNY are less simple than HYPOGYNY; the Epigynous *Sympetalæ*, *Choripetalæ*, *Monocotyledones* are, therefore, treated last; the *Hydrocharitaceæ* are considered last under the *Helobieæ*, etc. ZYGOMORPHY is younger than ACTINOMORPHY; the *Scitamineæ* and *Gynandræ*, therefore, follow after the *Lilliforæ*, the *Scrophulariaceæ* after the *Solanaceæ*, *Linaria* after *Verbascum*, etc. FORMS WITH UNITED LEAVES indicate younger types than those with free leaves; hence the *Sympetalæ* come after the *Choripetalæ*, the *Sileneæ* after the *Alsineæ*, the *Malvaceæ* after the *Sterculiaceæ* and *Tiliaceæ*, etc.

"ACYCLIC (spiral-leaved) flowers are older than cyclic (verticillate-leaved) with a definite number, comparing, of course, only those with the same fundamental structure. The *Veronica*-Type must be considered as younger, for example, than *Digitalis* and *Antirrhinum;* these again as younger than *Scrophularia; Verbascum*, on the contrary, is the least reduced, and, therefore, considered as the oldest form. Similarly the one-seeded, nut-fruited *Ranunculaceæ* are considered as a later type (with evident abortion) than the many-seeded, follicular forms of the order; the *Paronychieæ* and *Chenopodiaceæ* as reduced forms of the *Alsineæ* type; and the occurrence of few seeds in an ovary as generally arising through reduction of the many-seeded forms. The *Cyperaceæ* are regarded as a form derived from the *Juncaceæ* through reduction, and associated with this, as is so often the case, there is a complication of the inflorescence; the *Dipsacaceæ* are again regarded as a form proceeding from the *Valerianaceæ* by a similar reduction, and those in their turn as an off-shoot from the *Caprifoliaceæ*, etc. Of course these principles of systematic arrangement could only be applied very generally; for teaching purposes they have often required modification."

While there is wide difference of opinion among botanists as to the relative degree of complexity of some of the families, and the sequence adopted by Engler and Prantl in

their 'Natürliche Pflanzenfamilien' will appeal to many students as in some respects more philosophical, all the suggestions contained in this book must be regarded as very valuable.

Plants are here divided into five great divisions: (1) Thallophyta; (2) Muscineæ; (3) Pteridophyta; (4) Gymnospermæ; (5) Angiospermæ. We note in this a departure from some recent views where the divisions 2, 3 and 4 have been grouped under the primary division Archegoniatæ, and from others where the divisions 4 and 5 have been grouped as Spermatophyta.

Dr. Warming does not discuss the relative value of these different views, contenting himself with alluding to them. We may note that the disadvantage of recognizing the Archegoniatæ as above circumscribed is found in the fact that the female organs of the Angiosperms are also archegones. It must be admitted that the grouping here maintained has many points in its favor, but it is our opinion that the term 'sub-kingdom' is more explicit for the primary groups than 'division.'

The Thallophyta are divided into 'subdivisions': (a) Myxomycetes, (b) Algæ, (c) Fungi. It is said of the Myxomycetes that "they occupy quite an isolated position in the vegetable kingdom, and are perhaps the most nearly related to the group of Rhizopods in the animal kingdom." The Bacteria are treated, unphilosophically, it would seem to us, as a family of Algæ, being grouped with the Schizophyceæ under the class Schizophyta. The treatment of the higher Algæ and Fungi is not essentially different from that of other recent authors. (It should be remarked that the arrangement and description of the Thallophytes is largely contributed by Dr. E. Knoblauch.) The Fungi imperfecti are placed at the end of the subdivision, and the only groups admitted to this category are the Saccharomyces-forms, the Oidium-forms and Mycorhiza. Lichens are discussed under Ascomycetes and Basidiomycetes.

The Muscineæ are treated as (1) Hepaticæ and (2) Musci frondosi. Neither in these nor in the Pteridophyta do we find any views very different from those of other recent authors. In the Gymnosperms we find the three classes, Cycadeæ, Coniferæ and Gneteæ, maintained; the Coniferæ are distinctly separated into two families, Taxoideæ and Pinoideæ, which is a suggestion of much importance.

Under the Angiospermæ we find a discussion of the systematic value of the primary group Chalazogams, recently suggested by Treub. It will be remembered that Treub found that in the curious genus Casuarina the pollen-tube entered the ovule near the chalaza, and on this character proposed to divide the Angiosperms into Chalazogames and Porogames, *Casuarina* being the only genus known to him that would fall into his first group. Dr. Warming concludes, from the more recent observations of Nawaschin and Miss Benson, which indicate the similar entrance of the pollen-tube in *Betula*, *Alnus*, *Corylus* and *Carpinus*, that our knowledge of this phenomenon is as yet too meagre to warrant us in maintaining the views of Treub, and so he adopts the usual grouping into Monocotyledones and Dicotyledones. His primary grouping of the Monocotyledones is as follows: (1) Helobieæ, Juncaginaceæ being taken as the lowest type; (2) Glumifloræ, in which he includes the Juncaceæ, a position which we do not believe can be satisfactorilly maintained; (3) Spadicifloræ; (4) Enantioblastæ; (5) Liliifloræ; (6) Scitamineæ and (7) Gynandræ. It will be observed that in this arrangement he differs considerably in detail from that of Eichler and Engler and Prantl. The primary division of the Angiospermæ is into (1) Choripetalæ, beginning with Salicaceæ and ending with Hysterophyta (parasites such as the Lorantha-

ceæ and Santalaceæ), and (2) Sympetalæ, beginning with Bicornes and ending with Aggregatæ.

An appendix, contributed by the translator, gives a useful tabulation of the system of Ray (1703), Linnæus (1733), A. L. de Jussieu (1789), A. P. DeCandolle (1819), Endlicher (1836–40), Brongniart (1843), Lindley (1845), A. Braun (1864), Bentham and Hooker (1862–83), Sachs (1882), Eichler (1883), Engler (1892). N. L. B.

The Story of the Stars. G. F. CHAMBERS. New York. D. Appleton & Co. 1895. Pp. 160.

THE Messrs. Appleton have begun with this small monograph their *Library of Useful Stories*, a series of paper covered booklets intended to embrace the ground of science, history, etc. This initial number, by Mr. George Chambers, an English astronomical writer of long experience, proves to be rather better than a first impression would lead one to judge; for the illustrations, which first strike the eye, are for the most part simply execrable. What excuse for the absence of more and better ones, in these days of inexpensive engraving? Its curiously insular mannerisms might readily have been corrected by a half hour's work of an American editor, who should also have toned down those provincial oddities of style which mar this book even more, because of its smaller size, than the same author's large *Descriptive Astronomy.*

Curiously false implications are wrought into the first chapter, though only a page or two in length. If the manifold uses of astronomy are to be competently brought before the public mind to-day, and the reasons for the support of that science from the public exchequer suitably defended, it is only by telling a few simple things exactly as they are. Now, it may be true in England that, if "the staff belonging to either establishment [the Royal Observatory or the Nautical Almanac Office] were to resort to the fashionable expedient of a strike for higher pay," then, among other dire results, "Our railway system would become utterly disorganized. A few trains could run, but the intervals between them would have to be considerable, and they could only travel by daylight and at very low speeds," but we do not exactly see why. Rather the fact is that, if both these establishments were permanently closed henceforth, the present state of astronomy is such that all the public business of determining time for railways and of preparing data for navigating ships could be done for the fiftieth part of the budget now devoted to the Nautical Almanac and the Royal Observatory; and any government maintaining such costly establishments, with their corps of trained observers and expert computers, merely for this simple though important purpose, would be very foolish indeed. Not only would the expenditure be extravagant, but wholly unjustifiable. These institutions are maintained for quite other purposes; and the significant work of the great government observatories (excellently done in England, France and Russia, and which in this country we have been trying for a half century to do, though not succeeding very well because the proper organization is lacking) lies in quite other fields, the immediate serviceableness of which is by no means universally conceded. Blanketing all this under the antiquated plea of utility in time and navigation is clearly wrong and wholly indefensible.

Mr. Chambers's attempt to popularize seems rather hard, and on the whole of doubtful success. Excellent scientific explanations go on for a while, when suddenly the author, seemingly suspecting that he is less interesting than he ought to be, plunges patchily into something purely literary, or indulges in some incongruous expression not exactly ludicrous, but giving an undignified

cast to essays on the most dignified subject in the whole range of the sciences. No carelessness or vulgarity in style was ever a compliment to the literary taste of a reader, and neither the cause of literature, science nor anything else is likely to be enhanced by allusions to 'some Germans nibbling' at stellar photometry; or by ponderous anecdotes about hypothetical carrots, "that grew so well that the roots reached right through to the other side of the earth."

The proof revision has been none too carefully done—illustrations on pages 60 and 116 have been interchanged; the incorrect spelling of Palitzsch would not perhaps attract attention, except that the author, being also the compiler of a handy little German-French-English lexicon, we expect better things of him; and while 'Bob' passes current everywhere for Robert, 'Boberts' will scarcely do for Roberts. The general scientific reliability of statement is fully up to the standard expected of Mr. Chambers, and only one or two inaccuracies need be pointed out—at the middle of page 18, where he should have written, 'a *vertical* plane passing through the zenith;' and on page 73, where the exact opposite of what is meant is inadvertently said, regarding the stars 'converging towards' a point in Hercules.

Of course in so small a book one must not expect everything; but some omissions are noteworthy. In even a magazine article about the stars a single page about their distances would be only too brief, but Mr. Chambers gives only this amount in a volume of 150 pages, with no allusion to the name of Bessel in this connection, or Brünnow or Gill. The classic work of Dr. Gould should not have been omitted. The superb advances of stellar photography in the hands of the brothers Henry, Russell, Gill, Barnard, Roberts, Wolf and others are barely alluded to, or left out entirely. The accurate researches on the brightness of stars by the Potsdam astronomers are wholly ignored. If the space of six pages could be given to 'The Stars in Poetry,' and a third of that amount to speculative 'rubbish' regarding the origin of the Milky Way, is it quite the thing to have crowded out completely the nebular hypothesis, which has engaged such master minds as Herschel, La Place, Lord Kelvin and Darwin? Several chapters are almost purely descriptive, or mere geography of the heavens, as if a handbook for the use of small telescopes; a little yeast here would have done no harm; but it should be pervasive and inherent—not added as an afterthought. Mr. Maunder has appended an excellent chapter on the marvels of the spectroscope as applied to the stars and nebulæ.

It is not, however, intended to imply that there is not much that is excellent in Mr. Chambers's *Story of the Stars*, both as to form and arrangement. Its convenient size, clear type and authoritative statements (even with occasional lapses into 'dread' technicalities) render it, on the whole, an intelligible and interesting booklet, which will be a vast help to the student and general reader, and is worth double what the publishers ask for it. But the author has far from succeeded in making the most and best of his opportunity. DAVID P. TODD.

AMHERST COLLEGE.

The World of Matter: A Guide to the Study of Chemistry and Mineralogy. By HARLAN H. BALLARD, A. M. Boston, D. C. Heath & Co. 1894.

The object of this book is apparently to enable those who may not have an opportunity to study natural phenomena in a thorough way to obtain some comprehension of the objects and methods of scientific investigation by means of a few well chosen experiments. The object is a good one; will a study of this book further it?

It is impossible to say definitely, yes or no. The explanations, so far as they go, are generally excellent, but the tendency of the

author to preach rather than to guide is often noticeable. After most properly bidding the student accept as fact no scientific statement capable of easy demonstration until he has proved it such, the book contains several chapters with hardly a single one of the statements made supported by experiment. For instance, we find (p. 179) that "we have now become somewhat familiar with," among other elements, "aluminum and iron; and we have incidentally become acquainted with a number of their more important compounds." Experimentally, how? Thus: The student is bidden to look for iron ore in soil, to write down what he already knows about iron, to examine the physical properties of siderite, to heat a piece of pyrite, and to note the physical properties of slate and of feldspar. That is all. Now, this is not experimental chemistry; it is boiled-down encyclopædia.

On the other hand, after having studied Ice, Water, Fire, Air, Earth and Quartz, molecules and atoms and all the other fascinating mysteries are brought in in a chapter called A Lesson in Chemistry (!); later, atomic weights are given and symbols in plenty. After having stated as facts the Laws of Chemical Combination, the author later, without further explanation, gives the following formulæ for some of the minerals the student is to work with—of course, with their names: Fe_7S_8, $(FeMnZn)_2O_4$, $(CaMgAlFe)SiO_3$, $(KFeMgAl)_2SiO_4$, $Li_6Al_8Si_{15}O_{45}$, $(CaMg)_8(AlFe)_4Si_7O_{28}$.

The directions are in some cases almost tediously explicit, and this is right; frequently, however, they err on the other side. The student is given directions to use phosphorus, and occasionally other dangerous substances, without a word of caution. Considering the inexperience of the student, and the fact of his working probably alone, this is a matter of some importance.

To sum up, if all the theoretical portion of the book, all symbols, atomic weights, etc., had been left out, and a few experiments on the *chemical properties* of substances like iron and aluminium—to mention but two—put in to fill the vacuum, Mr. Ballard's book would have filled a lack. It cannot at present—at least, unassisted.

WYATT W. RANDALL.

NOTES AND NEWS.

AT the meeting of the trustees of Columbia College, on May 6th, President Low subscribed one million dollars for the construction of the new library building. He stated that it is to be a memorial to his father, the late A. A. Low, 'a merchant who taught his son to value the things for which Columbia College stands.' The trustees passed the following resolution:

Resolved, That the trustees accept with the deepest sense of gratitude the offer conveyed by President Low in his letter of May 6, 1895, subject to all the conditions therein expressed; and that the Clerk of the Board be instructed to convey to the president the thanks of the trustees for this most munificent and opportune gift, unprecedented in the scale of its generosity, and affording fresh evidence of the president's unbounded devotion to the interest of the College.

President Low's gift was accompanied by the following conditions which add to rather than detract from its value: That twelve Brooklyn scholarships for boys be established in Columbia College, and twelve Brooklyn scholarships for girls in Barnard College; that eight university scholarships, to be known as the President's University Scholarships, be established; that a university fellowship, the Class of '70 Fellowship, be established. President Low graduated in the class of '70.

At the same meeting Mr. W. C. Schermerhorn, chairman of the trustees, subscribed three hundred thousand dollars for the Natural Science Building, or other building or part of building that may be more needed.

CARL VOGT, Professor of Natural History in the University of Geneva, died in Geneva on May 5th, at the age of seventy-seven years. Vogt made important contributions to physiology, zoölogy and geology, but became most widely known through his work 'On Man' (1863), written from a materialistic point of view. He was born at Giessen, July 5, 1817, studied at that place, under Liebig, and at Berne, worked with Agassiz and was made professor at Giessen. After taking a prominent part in the Frankfort Parliament of 1848, he considered it prudent to retire to Switzerland, and from 1852 was professor in the University of Geneva.

MISS CRANE, through her excellent reviews and synopses of current brachiopod literature, certainly keeps the public well informed of the progress made in this department, and from time to time she ventures to make contributions of her own to the knowledge of the class. Her latest paper, *The Evolution of the Brachiopoda* (Geological Magazine, February and March, 1895), is a combination of the results and conclusions reached in the most recent investigations by various authorities, together with a general application of the facts to a scheme of phylogeny. The profound changes which have been made of late in the classification of the Brachiopoda through the application of modern principles of evolution are graphically stated:—"The Brachiopoda now seem to justify the prescience of Darwin. Formerly regarded as one of the most obstinate difficulties in the way of the demonstration of the evolution of the invertebrate life on earth, they now bid fair to become a remarkable illustration in favor of it."

THE building containing the entomological department of the Amherst State College is being enlarged so that the capacity of the laboratories will be doubled.

MONEY has been given to defray the expenses of transporting to Mount Hamilton and erecting there the great reflecting telescope presented to the Lick Observatory by Mr. Edward Crossley, of England. A reflecting telescope was included in the plans for the Lick Observatory made 21 years ago, and before Mr. Crossley presented the telescope to the observatory Professor Holden had been in correspondence with him, with a view to purchasing it. It is hoped that the telescope will be ready for use before the close of the current year.

THROUGH a gift of W. C. McDonald, McGill University has secured 35 acres of land for botanical gardens and an observatory.

THE bill consolidating the Astor, Tilden and Lennox libraries has been approved by Gov. Morton. The present site of the Lennox library will probably be adopted.

DR. GUSTAV HIRSCHFELD, Professor of Classical Archæology in the University of Königsberg, died on April 20th.

A JOINT meeting of the Scientific Societies of Washington, was held on May 10th, on the occasion of the delivery of the annual address of the President of the National Geographic Society, the Hon. Gardiner G. Hubbard. The subject of the address was 'Russia.'

DR. FERDINAND BRAUN, of Tübingen, has been appointed Professor of Physics in the University of Strasburg, succeeding Professor Kohlrausch.

DR. W. S. HALL has accepted the Davis Professorship of Physiology in the Northwestern University Medical School, of Chicago.

THE trustees of the University of Pennsylvania have accepted with regret the resignation of Professor Harrison Allen from the Professorship of Comparative Anatomy and Zoölogy.

ACCORDING to the *American Geologist*, Mr. Warren Upham, recently of the Minnesota

Geological Survey, has removed to Cleveland, Ohio, to accept the position of librarian for the Western Reserve Historical Society, and Mr. H. F. Bain has been elected Assistant State Geologist of Iowa in place of Dr. Charles R. Keyes, who recently resigned to take charge of the Missouri Survey.

THE Provincial Legislative Assembly of Ontario has authorized a grant of $7,500 towards defraying the expenses of a meeting of the British Association at Toronto in 1897, should the Association decide to accept the invitation that has already been received from Toronto.

THE Society of German Naturalists and Physicians will meet at Lubeck from September 16th to 21st.

THE death is announced of Dr. Tomsa, Professor of Physiology in the University of Prague.

IT is stated that Dr. Bertillon has discovered a new method for identifying handwriting by enlarging the letters by photography and measuring the alterations due to beating of the pulse.

THE celebrated Villino Ludovisi, in Rome, has been leased for the new American School of Architecture and Archæology.

ACCORDING to the *Medical Record* 14 of the 140 Medical Schools of the United States now require a four years' course.

SWAN, SONNENSCHEIN & Co. announce for publication next autumn a translation by Professor E. B. Titchener, of Cornell University, of Professor O. Külpe's *Grundriss der Psychologie*.

ACCORDING to a note in the London *Times*, the excavations by the American School at the Heraion of Argos, under the direction of Professor Waldstein, which were resumed this spring, have been very successful. Two hundred and fifty men have been employed on the work. Besides the two temples and five other buildings previously discovered, a large and well-preserved colonnade 45 metres long has now been found 25 feet below the surface south of the second temple. The discoveries include parts of metopes, two marble heads of the best Greek period, a hundred objects in bronze and gold, gems, vases and terra cottas of the Homeric period, as well as numerous scarabs and several Mycenean tombs with Argive inscriptions on bronze, probably of a religious character. The excavations, which are now in the fourth season, will be completed this year. They rival the French excavations at Delphi in magnitude and importance, representing all the periods of Greek life from prehistoric to Roman epochs.

THE residue of the estate of Mary D. Peabody has been left to the Catholic University of Washington, for the foundation of scholarships (probably three or four of the value of $5,000 each) in the chemical and physical sciences.

THE *Medical Record* gives an account of the malarial map of Italy, recently issued by the Italian Bureau of Statistics. It is based upon the death returns during the years 1890–92. The varying intensity of the disease in different sections is shown by modifications of color. In the three years there were 50,000 deaths from malarial causes, or 54 in 100,000. The worst districts, where the mortality is as high as 8 in 1,000, are in southwestern Sardinia, southeastern Sicily, the Pontine marshes, the district at the head of the Gulf of Taranto, and the southeastern slope, from the promontory of Gargano south to the Ionian Sea. Districts where malaria prevails, but not so intensely as to be fatal, are the lower reaches of the Po, Grosseto in Tuscany, the mouth of the Tiber, and the district near Salerno and the temples of Pæstum. In Rome itself malaria has sensibly declined; the deaths in 1881 were 600, in 1892 only

139. The general mortality from this cause in Italy has remained pretty constant; the average is 15 or 18 per 1,000.

PROGRAMS of the School of Applied Ethics, which opens at Plymouth, Mass, on July 8th, may be obtained from the Secretary, S. B. Weston, 1305 Arch street, Philadelphia.

THE Metropolis Law School has been united with the Law School of the University of the City of New York.

ACCORDING to the prospectus of the Cotton States and International Exposition, which opens at Atlanta, Ga., on September 18th, science will be well represented. There will be special buildings for machinery, minerals and forestry, agriculture, electricity and transportation. The United States Fish Commission will supply an aquarium with tanks occupying 10,000 square feet, and the National Bureau of Forestry will exhibit models showing methods of forest cultivation and preservation.

WE learn from a notice by Prof. Ziwet, in the April number of the *Bulletin of the American Mathematical Society*, that the first installment of the *Répertoire bibliographique des Sciences Mathématiques* has been issued. This consists of a set of 100 cards, 14x8 cm., on each of which about 10 titles are printed. The series is published by Gauthier-Villars in Paris and sells for two francs. It was decided at an international meeting held in Paris under the auspices of the French Mathematical Society to prepare a complete bibliography of the literature of mathematics since 1800 and of the history of mathematics since 1600.

MR. CLEMENS R. MARKHAM, President of the Royal Geographical Society, in a paper read before the Royal United Service Institution, urges the importance of an Antarctic expedition from a scientific and naval point of view, and recommends that it be undertaken by the British Government.

THE correspondent of the *Evening Post* announces the following new appointments at Bryn Mawr College: Dr. Florence Bascom, the only woman who has received the Ph. D. from Johns Hopkins University, now of the Ohio State University, Reader in Geology; Mr. Richard Norton, Lecturer in Archæology; Dr. M. L. Earle, Ph. D., of Columbia, Associate Professor of Greek; Mr. P. E. More, Associate in Sanscrit; and Dr. Alfred Hodder, Lecturer in English Literature.

DR. PEAT, of Butler, Pa., has cast a lens 60 inches in diameter for the telescope for the American University (of Washington).

MR. LEONARD T. METCALF has been appointed Professor of Mathematics in the Amherst State College.

The Bakerian Lecture before the Royal Society on May 9th was based upon a research conducted by Messrs. A. Vernon Harcourt and William Esson, on 'The Laws of Connexion between the Conditions of a Chemical Change and its Amount.'

IN a brochure of fifty pages issued in connection with an exhibit at the World's Fair, Mr. Gifford Pinchot gives an account of an attempt to introduce a proper system of forest management upon the estate of Mr. George W. Vanderbilt in North Carolina, together with the result of the first year's work. Biltmore is about two miles from Asheville, on the table land in western North Carolina. The estate includes 3,891 acres of woodland on the banks of the French Broad River. The forest is composed chiefly of young oaks and other deciduous trees, the best timber having been cut away. Fires and neglect have also done much injury. This forest has been divided into suitable blocks and compartments, and put into the care of a competent forester for improvement while at the same time yielding money returns to the owner. The location of the forest, soil, climate, kinds of trees, treatment previous to coming into the

hands of the present owner, improvement, cuttings and other topics are discussed. While it was not expected that the forest would be self-supporting from the start, it has been nearly so, the expenditures for the year ending April 30, 1893, being $9,911.76, and the income from sale of ties, cord-wood, lumber and posts, together with the estimated value of stock on hand, amounting to $9,519.36. Part of the tract will be managed on the regular high forest system with a 150-year rotation; the rest, on a selection system. Steps have also been taken to reforest a thousand acres of waste land, using many kinds of native and foreign trees. In connection with this work it is designed to build up an arboretum second to none in the world. This is under the direction of Mr. Frederick Law Olmsted. Already there are in the nursery more kinds of trees and shrubs than in the gardens at Kew, and the number is being steadily increased. This arboretum will form the borders of a drive about five mile long. Careful records are being kept in connection with the work, and a forest botanical library, already of considerable extent, will furnish the necessary aid to study. Accompanying the report is a map of the forest and a number of good half-tones showing original condition, proper and improper methods of lumbering, etc. This is the first time proper forest management has ever been undertaken in the United States, and as time goes on the results will undoubtedly become an object lesson of prime importance, and one badly needed by the American public, whose delight from the earliest settlement of the country has been to destroy trees.

E. F. S.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

THE following are abstracts of the communications presented at the 33d meeting, April 24, 1895:

W J MCGEE. 'The topographic development of Sonora.'

The territory described, lying between the Gila river on the north and the Rio Sonora on the south, and extending from the Sierra Madre to the Gulf of California, is about 400 by 200 miles square. Essentially it consists of an undulating plain with embossed mountain ranges. The plain varies from sea-level to some 4000 feet in altitude; the mountain ranges, commonly 4000 feet or less in height above the plain, are rugged, narrow and generally parallel, trending somewhat east of south. These ranges are remnants of larger mountain areas, shaped by erosion, and sometimes they are connected by transverse ridges which, like the ranges themselves, are residua of ancient masses. The area is one of complete gradation within itself, *i. e.*, the rainfall is so slight that the material degraded from the mountain is aggregated on the intermontane plains, as the storm-waters sink or evaporate—for none of the rivers between the Gila and Yaqui ever reach the sea. Certain peculiarities of the topography grow out of this condition.

The entire plain inclines southwestward, having evidently been tilted in this direction during late geologic time, though the date is not yet fixed. A consequence of this tilting was the stimulation of the streams flowing westward, southward and southwestward, and partial paralysis of the streams flowing in the opposite direction; and by reason of previous adjustments of topographic processes and products under the peculiar climatal conditions of the region these effects were greatly increased. Accordingly the southwestward-flowing streams retrogressed and pushed their headwaters through the parallel ranges and sometimes through the transverse ranges connecting them, while the northeastward-flowing streams practically ceased to corrade. Accordingly the area is characterized

by retrogression; the main waterways diverge from the main valleys, and cut through the ranges and athwart the valleys; and the primary and secondary divides do not coincide with the mountain ranges, but traverse the valleys in a singularly erratic manner. By reason of the combination of epeirogenic and meteorologic conditions, the region affords a remarkable example of the retrogression of streams and of the development of unusual topographic forms thereby.

WHITMAN CROSS. 'The Geology of the Cripple Creek Gold Mining District, Colorado.' This important new gold district lies on a granite plateau, some ten or twelve miles southwest of Pike's Peak, at an elevation of 9,000 to nearly 11,000 feet. There is at this point a small volcanic vent, to be regarded as an outlier of an extensive volcanic region to the westward, lying between South Park and the Arkansas River.

While the area of the Cripple Creek volcano is small, there has been a very complete cycle of events at this center. Explosive eruptions in the earlier periods built up a cone of fine tuff and breccia, through which numerous eruptions in narrow fissures and irregular channels took place in later times. Erosion has now removed a large part of the ejected material, though not clearly disclosing the volcanic neck.

The igneus products of the volcano are andesites of several kinds, phonolite, phonolitic trachyte, nepheline-syenite, syenite-porphyry, and several dense varieties of basalt. Phonolite is the specially characteristic rock of the center, and in dike form in granite occurs for several miles about it.

Fumarole and solfataric emanations of chlorine, fluorine and sulphurous gasses undoubtedly characterized certain periods of the volcano, followed by hot waters containing the same agents in solution. By these processes the rocks of the district have been very extensively decomposed. The ore deposits are very intimately connected with the volcanic center.

This communication presented the general geological results of a detailed study of the district made last fall. An examination of the ore deposits was made at the same time by Prof. R. A. F. Penrose, Jr., and the two reports, with a geological map, will be issued by the U. S. Geological Survey during the coming summer.

W. H. WEED. 'The Shonkin sag, an abandoned channel of the Missouri river.' The Shonkin sag is a peculiar topographic feature of the country south of the big bend of the Missouri River in central Montana. It is an abandoned river channel which was formed by the waters of the Missouri River flowing around the margin of an extension of the great Canadian ice sheet (the Laurentide glacier). The sag consists of a winding valley from a quarter of a mile to two miles wide with rocky bluff walls, and holds a succession of lakes, several of them without outlet. The continuity of the channel is interrupted by modern stream valleys cutting it transversely, but their later origin is clearly apparent, and even the settlers of the region recognize the fact that the sag is an old water way. It begins near the mouth of Highwood Creek, east of the Great Falls of the Missouri River, and extends in a general easterly direction over 100 miles to the mouth of Judith River. Throughout its course the northern wall marks the limit of the glacial moraine. Glacial drift is found in a few places a short distance south of the channel, but in small quantity. In general the sag defines the moraine front. It is, therefore, believed that the ice sheet ponding the waters of the Missouri near the mouth of Sun River deflected the stream, which at that time flowed northward, and caused it to flow about the margin of the ice. Upon the recession of the glacier the river abandoned this temporary channel for the old valley to the northward, which was

but partially filled by glacial material. The present course of the Missouri, for some distance below the cataracts, is cut in black shales of the Fort Benton period, capped by 100–250 feet of glacial till and silt.

WHITMAN CROSS,
Secretary.

ENTOMOLOGICAL SOCIETY OF WASHINGTON.

THE 108th regular meeting was held May 3d. Mr. L. O. Howard read a paper entitled 'Some New Scale Parasites,' in which he discussed several species of the family Chalcididæ which are new to science, and which are important parasites of destructive scales. A paper entitled 'Two Leaf-beetles that Breed on the Golden-rod,' by F. H. Chittenden, was read by title, and another, 'Sexual Dimorphism in the Scolytid Genus Xyleborus,' by E. A. Schwarz, was also read by title and referred to the committee on publications. Mr. Ashmead presented a communication on Lysiognatha, a new and remarkable genus in the Ichneumonidæ. The form described was an extraordinary one, possessing the head and jaws of the Braconid sub-family Alysiinæ, the wings and remainder of the body resembling those of the Ichneumonid subfamily Ophioninæ. Mr. Ashmead considered it typical of a new sub-family of the Ichneumonidæ. Dr. Theodore Gill expressed himself as of the opinion that the form is really typical of what should be a new family. A note from Mr. H. G. Barber, of Lincoln, Neb., a corresponding member of the Society, was read by the secretary. The note was entitled 'Food-habits of *Hypatus bachmanni.*' This butterfly, which has recently been observed migrating in great numbers in the Southwest, has been previously supposed to feed only on species of Celtis. Mr. Barber considers Symphoricarpos to be probably its favorite food plant. Mr. W. T. Swingle made some remarks on the effects of the December and February freezes in Florida upon the insects injuring the orange. The really important insects, namely, the red scale and the white fly, have been seriously checked. All specimens occurring upon foliage have been killed. In discussing this paper, Mr. C. L. Marlatt called attention to the fact that the serious injury to the trees caused by the cold has already resulted in the appearance of a number of bark-boring beetles, which will undoubtedly do much damage during the next two or three years.

L. O. HOWARD,
Recording Secretary.

NEW BOOKS.

Proceedings of The American Association for the Advancement of Science for the Forty-third Meeting held in Brooklyn, N. Y., August, 1894. Salem, The Permanent Secretary. 1895. Pp. xiii + 486.

Der Gute Geschmack. LOTHAR ABEL. Vienna, A. Hartleben. Pp. vii + 368.

The Geological and Natural History Survey of Minnesota, Vol. III., Part I., Paleontology. N. H. WINCHELL. Minneapolis, Minn., Harrison and Smith. 1895. Pp. lxxv + 474.

John Dalton and the Rise of Modern Chemistry. SIR HENRY E. ROSCOE. London and New York, Macmillan & Co. 1895. Pp. 212. $1.25.

Missouri Botanical Garden. Sixth Annual Report. WILLIAM TRELEASE. St. Louis, Mo., The Board of Trustees. 1895. Pp. 134.

The Origins of Invention. OTIS T. MASON. London, Walter Scott; New York, Charles Scribner's Sons. 1895. Pp. 413. $1.25.

Chemical Analysis of Oils, Fats and Waxes. From the German of PROFESSOR DR. R. BENEDICT. Revised and enlarged by DR. J. LEWKOWITSCH. London and New York, Macmillan & Co. 1895. Pp. xviii +683. $7.00.